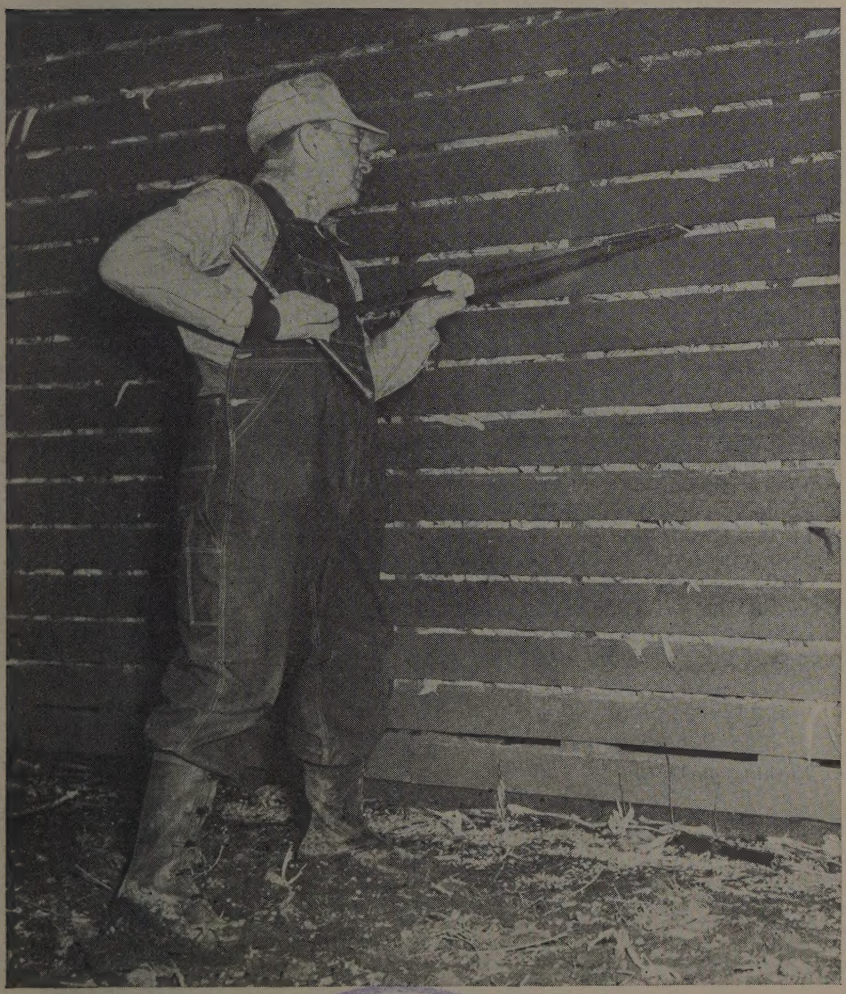
STORAGE OF EAR CORN ON THE FARM



COMMONWEALTH MYCOLOGICAL INSTITUTE
APR. 1950

Farmers' Bulletin No. 2010

U. S. DEPARTMENT OF AGRICULTURE

BALANCED ABUNDANCE

Protects producers and consumers
Stabilizes prices
Assures fair income
Helps conserve soil

This bulletin is issued with a view to aiding farmers in achieving the objective of balanced abundance. By balanced abundance we mean the production and maintenance of adequate supplies of grains and other farm commodities in the interests of both producers and consumers.

The Federal Government provides loans on grain in farm storage against the time that the grain is needed for domestic and foreign consumption. It enables farmers to obtain the full value of their grain as it is needed in the processes of orderly marketing. But providing the physical means of protecting the harvested grain on the farms as to both quantity and quality is the responsibility of the farmers themselves.

Surveys have shown that today there is insufficient farm storage to accommodate the great grain crops now being produced. Modern harvesting is done so rapidly, so much grain moves to market at once, that a farm without a granary to safeguard the quality of grain and to ease the flow to market is physically and economically handicapped. Some storage facilities have been built since the end of World War II, but clearly not enough to protect the Nation's grain supply which properly should be stored on the farms. More need to be built.

We hope that for the purposes here expressed our farmers will find useful the information and suggestions that are contained in this publication on farm storage.

Charles F. Brannan

Secretary of Agriculture.

Washington, D. C. Issued September 1949.

STORAGE OF EAR CORN ON THE FARM[1]

By C. K. Shedd, *senior agricultural engineer, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, in consultation with other representatives of the Bureau and representatives of the Bureau of Entomology and Plant Quarantine and the Grain Branch, Production and Marketing Administration, of the United States Department of Agriculture, and of the Illinois, Indiana, Iowa, and Kansas Agricultural Experiment Stations*

Contents

	Page
Introduction	1
Good corn, properly stored, is required security	2
Ear-corn storage	2
Precautions in storing corn	3
Crib location	4
Crib requirements	4
Width of cribs and ventilation	5
Openings in crib walls	6
Types of cribs	7
Rectangular cribs	7
Round cribs	7
Buildings for forced ventilation	12
Conveniences for handling corn	13
Crib construction	15
Foundations	15
Anchoring	16
Floors	16
Wall framing and bracing	16
Roof	17
Crib ventilators	18
Mechanical drying	20
Drying with unheated air	21
Amount of air needed	23
Limit of moisture	23
Drying with heated air	24
Cost of drying corn	26
Rat control	26
Corn storage plans	26

INTRODUCTION

CORN and other feed grains are the lifeblood of the Nation's livestock industries. Most of these grains are used on the farms, but large quantities are used also in the commercial manufacture of many food and industrial products. In planning our long-term livestock industries it is essential that adequate reserves of corn and other feed grains be maintained at all times. These reserves can best be protected on the farms where they are produced. This involves the use of modern cribs and bins to safeguard the quality of the grain and make it eligible for price-supporting loans and purchase agreements.

[1] This bulletin has been prepared chiefly for commercial corn-producing areas. Farmers in other areas, where climatic conditions may differ appreciably from those in commercial areas, should get in touch with their State agricultural college for storage details. This bulletin supersedes Corn Storage in the Ever-Normal Granary, AAA Commodity Information Series, 1939.

GOOD CORN, PROPERLY STORED, IS REQUIRED SECURITY

The loan program for corn provides that the stored corn shall be the only security the Government has for its loan. Hence, it is essential that only good-quality corn be stored and that it be placed in modern cribs or bins where it will not be subject to losses in quantity or to damage from moisture, insects, rodents, or other sources. To qualify for a loan ear corn must be merchantable husked field corn and contain not more than 20.5 percent moisture; deductions in amount of loan will be made if the corn contains more than 15.5 percent moisture. Approval of storage structures is under the direction of the county agricultural conservation committees.

Purchase agreements are available to farmers, under which the Commodity Credit Corporation agrees to buy corn from farmers near the end of the marketing year at applicable loan levels. This is an additional price stability mechanism that guarantees farmers not less than the support price during practically the entire marketing year. Corn that is under purchase agreement also should be stored safely, for the Government will not accept such corn unless it meets the quality specifications for corn under loan.

EAR-CORN STORAGE [2]

Corn differs from other grain crops in being nearly always too damp to store in a tight bin when harvested. Corn therefore requires further curing after it has been harvested. The main advantage crib storage has over tight-bin storage is that the necessary additional curing or drying of the corn will take place when the husked ears are stored in a crib. Storage in a tight bin gives dry corn better protection.

Corn stored in a crib is more or less exposed to weather. In northern areas there is usually some drifting of snow on top of the corn and into the spaces between the ears in winter storms. If the corn is left in the crib after it is once dry, it will regain moisture from the air in periods of damp weather.

Another disadvantage of crib storage is the difficulty in excluding rats and mice. No ordinary construction will keep out all of these vermin.

Corn in a crib is exposed to insect infestation and cannot be fumigated. In Southern States where grain insects are a serious problem, crib storage of ear corn has not been successful except for short-time storage. In the commercial corn-growing area of the North Central States, insects in cribbed corn are not an important problem; and crib storage has been reasonably successful and is a firmly established practice.

---

[2] For information on storage of shelled corn see United States Department of Agriculture Farmers' Bulletin No. 2009, Storage of Small Grains and Shelled Corn on the Farm.

Under normal conditions in the central part of the Corn Belt, corn will have 18 to 20 percent moisture in the kernels and about 35 percent moisture in the cobs when harvested in the latter part of October or early in November. Ordinarily, the corn dries very little in the crib during winter. Under humid conditions during winter there may be a little increase in moisture in the kernels due to movement of moisture from cobs to kernels, and due to snow blown into the crib. Drying takes place as the weather warms up in spring. By June or July, under normal weather conditions, the grain will be down to 13-percent moisture content and dry enough to shell and store in a tight bin.

In some emergencies it may be necessary to store corn in a crib longer than a year but generally this is not a good practice. All corn to be stored into the second year should be shelled and stored in a weathertight bin whenever possible. The best time to shell is just as soon as the corn has dried to 13-percent moisture content. The corn will not stay this dry in a crib in humid weather.

PRECAUTIONS IN STORING CORN

Good judgment is necessary in selecting the time to harvest and crib corn. The urge to start early is strong. Particularly when a mechanical picker is used, it is advantageous to finish before the cornstalks have been weakened by weathering and before bad weather sets

Figure 1.—Caked and damaged corn found under the elevator spout when a crib was emptied. This results from poor performance of the picker and little or no manipulation of the spout during filling to distribute shelled corn and debris through the crib.

in. Corn dries faster in the field than in the crib, however, and the risk of loss due to delay in harvesting may be more than offset by spoilage if damp corn is cribbed.

Clean husking is important. Shelled corn, chaff, husks, and silks mixed with ear corn tend to fill the air spaces between the ears (fig. 1), thus cutting off air movement and preventing proper curing of corn in the crib.

Immature, or soft, corn generally is not of a desirable quality for long-time storage.[3] However, if the quality is good except for excessive moisture, it can be brought to good condition by mechanical drying, or in some cases, by use of ventilators (see p. 18).

CRIB LOCATION

The crib should be located in the farmstead group not only for convenience but also for protection of the corn against theft. The crib should not, however, be closely wind-sheltered by other buildings or trees. The force of the wind causes air circulation through a crib. Location close to another building or windbreak may reduce the amount of ventilation and be responsible for damage of the stored corn. A distance of 50 feet or more from other buildings also helps to minimize fire hazard.

A crib can be built in or as a part of a barn or other livestock shelter if it is desired only as a storage place for corn that will be fed during winter months. A crib so located is not sufficiently aerated to condition corn for summer storage. Furthermore, moisture given off by livestock is likely to prevent proper drying and may even cause corn moisture to increase during winter.

Good drainage away from all sides of a crib is desirable. Unless it is on a high foundation, no crib should be built on river or creek-bottom land subject to flooding. On the other hand, steep slopes are generally objectionable because of inconvenience in driving to and from the building, higher cost of foundations, and the possibility of foundations being undermined by erosion of the soil.

Location in a barn lot where livestock comes in contact with the crib generally is not desirable; but a concrete feeding floor for hogs along a sheltered side of the crib may be desirable on some farms.

CRIB REQUIREMENTS

There is a wide variety of corncribs and of materials suitable for their construction. Detailed discussion of all designs and materials cannot be included in this bulletin, but the basic service requirements can be stated briefly in general terms. Any crib that meets these requirements will give satisfactory and acceptable storage for ear corn,

[3] For suggestions on the handling and storage of soft corn see U. S. Department of Agriculture Farmers' Bulletin 1976, Handling and Storing Soft Corn on the Farm.

whether the building is new or old and whatever the materials used in its construction.

The basic service requirements are that the crib must:

1. Have adequate strength to hold the corn and resist the stresses set up as the corn settles.
2. Provide adequate ventilation to cure the corn.
3. Protect the corn from soil and surface moisture and from rain and snow.
4. Provide reasonable protection against thieves, rodents, fire, and wind damage.
5. Be accessible for inspection and sampling if the corn is to be offered as collateral for a Government loan. This means that crib walls must have openings that will admit an ear-corn probe to obtain samples from all parts of the crib.

Other desirable features in corncribs are:

1. Reasonable cost.
2. Convenience of filling and emptying.
3. Suitability for application of mechanical drying.
4. Durability and low up-keep expense, especially in permanent cribs.
5. Low cost, ease of erection, and portability, especially in temporary cribs.

WIDTH OF CRIBS AND VENTILATION

To avoid molding and spoilage in the crib after the coming of warm weather, ear corn must throw off a large amount of moisture during spring months. To reduce ear corn from 20 to 13 percent moisture in the kernels, about 8 pounds (nearly a gallon) of water must be removed from each bushel of corn. This can be done by crib storage only if there is good circulation of air through all parts of the crib.

From the standpoint of natural ventilation, the most important dimension of a corncrib is the width. Corn of high moisture content is most likely to dry in a narrow crib because the narrower the crib is, the freer is the movement of wind through the corn. The proper width of crib in a particular locality depends upon the date at which corn matures in ordinary seasons and upon prevailing weather conditions during the first 8 months of storage. Humidity of the air, temperature, sunshine, and amount of wind are all considered in determining the proper width of a crib.

Rectangular cribs in the Corn Belt should not have greater widths than those shown in figure 2; and unless mechanical drying is to be used, round cribs without interior ventilators should have a diameter not greater than one and one-half times those widths. The recommendations in figure 2 have been used a number of years, and experience has shown that regional requirements are about as the map

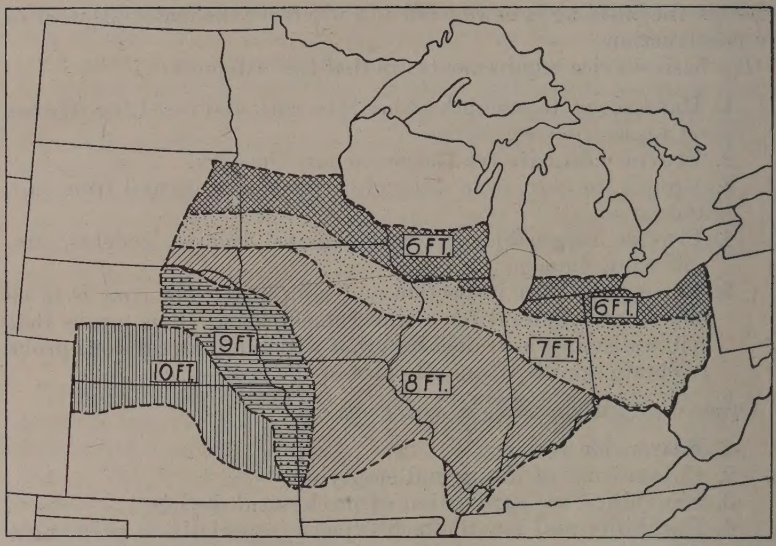


Figure 2.—Maximum crib widths recommended for the commercial corn area.

indicates. Corn will nearly always cure satisfactorily in fully exposed cribs of the widths shown on the map if its moisture content is not above 20.5 percent when harvested, if it is husked reasonably clean, and if there is no excessive accumulation of shelled corn or foreign material at any place in the crib.

If the corn contains more than 20.5 percent moisture or if the crib is wider than recommended, one or more ventilators (see p. 19) should be employed; or the corn should be dried mechanically.

OPENINGS IN CRIB WALLS

There is a wide variation in practice as to openings in crib walls. In picket or snow-fence cribbing, the openings between slats are more than half of the surface area. In welded steel mesh the openings usually are more than 90 percent of the area. In frame crib walls covered with 6-inch beveled cribbing spaced 1 to 1½ inches apart, the openings are 15 to 20 percent of the wall area. Some galvanized steel crib walls have been made in which openings constitute only about 3 percent of the wall area.

Minimum openings have not been tried under all conditions, but an 8- to 10-percent opening is probably about the least that will give good air movement. Ventilation is a little better with greater area of opening, but exposure to rain and snow is also increased. Louvered openings such as those obtained by use of beveled cribbing give some protection from rain.

In the northern areas it is best to make the top part of the crib structure as nearly snowtight as practicable and board the walls solid down 2 to 4 feet from the plates to prevent snow from drifting over the surface of the corn.

TYPES OF CRIBS

A few typical plans for corncribs, illustrative of the types of buildings that can be recommended, are listed on pages 26 and 27. Detailed working drawings of these buildings can be obtained as there explained. Plans also are available from other sources. The success of the building will depend upon use of the proper sizes of joists, studding, ties, and other structural members and upon proper joining of all parts of the building. It is therefore advisable to build from a detailed working plan. Some prefabricated buildings suitable for storage of ear corn are on the market but are not described in this bulletin.

RECTANGULAR CRIBS

Wood-frame cribs are nearly always rectangular, as is illustrated in plans Nos. 5717 to 5720. Wood framing works to good advantage in a rectangular building, and a crib of this shape gives good ventilation if the width follows the recommendations given in figure 2. Single cribs (fig. 3) give the best aeration of the corn because there is full exposure to wind on all sides.

Semipermanent single cribs of rectangular shape, as shown in figure 4 or in plan No. 5721, have been used on many farms when it was considered necessary to keep down the first cost of the structure. These cribs, when in good condition, provide acceptable storage. Usually they do not provide very good protection against rats. The expense of upkeep is likely to be greater than with a more permanent type. It is questionable that the total cost over a long term of years is any less with the semipermanent than with a permanent type of crib.

Double-crib buildings with a driveway (fig. 5), and sometimes with grain bins over the driveway as illustrated in figure 6 and in plans Nos. 5718 to 5720, are popular in the heaviest producing areas of the Corn Belt. Good results are obtained in curing corn in double cribs, even though aeration is not quite so good as in single cribs. The double-crib building may provide space for a vertical stationary elevator.

ROUND CRIBS

Temporary round cribs made with snow-fence cribbing or with welded steel cribbing (fig. 7) are used extensively in drier parts of the Corn Belt. A board floor blocked up 6 to 8 inches above ground

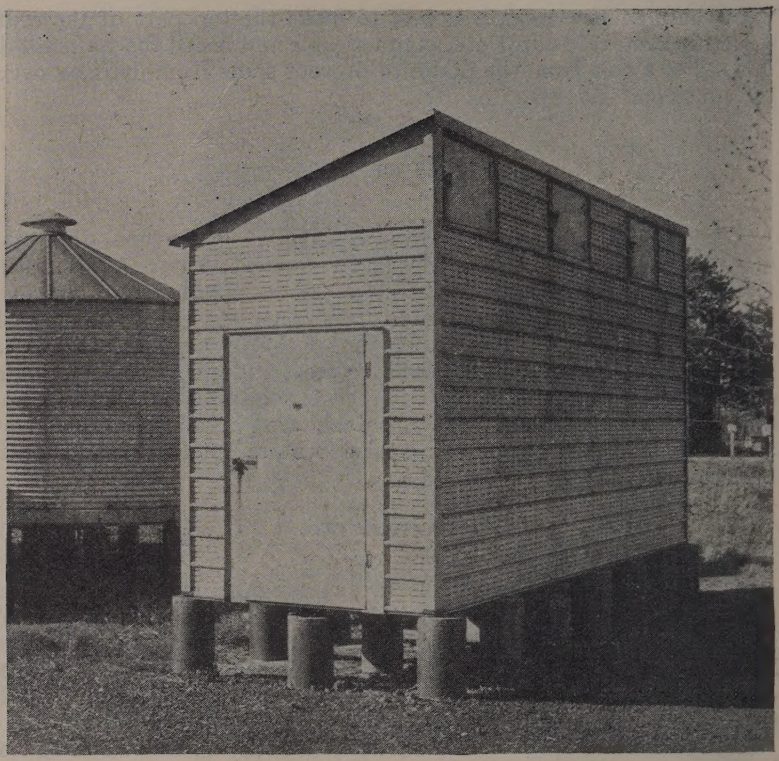


Figure 3.—A ratproof single crib of steel construction.

surface is generally used. It is difficult to build a good temporary roof for a round crib, and consequently many of these buildings are used without a roof. When so used, they are low-cost structures that can be erected quickly. They do not, however, provide safe storage through the summer without a roof, even in a comparatively dry climate. Several designs of round prefabricated cribs have been made (fig. 8). Where corn is to be fed to hogs, storage in a self-feeder saves labor (fig. 9).

Round cribs have been made of special designs of open building tile and concrete staves. In construction of these cribs either steel hoops or reinforcing in the mortar joints is used to hold the wall against pressure of the corn. Open building tile and concrete staves are used economically in the round building, but many of these structures have not provided good enough ventilation to dry the corn. If the diameter exceeds the recommendations given in figure 2 (p. 6) some kind of interior ventilator is needed. The ventilator should be designed for horizontal movement of air under wind pressure. (See p. 18.)

Figure 4.—A well-built semipermanent crib; it is well exposed to wind, has a good roof, and the floor is set above the ground.

Figure 5.—Double crib, each side 8 by 36 feet with a 10-foot wall; no bins above driveway; both cribs filled from one roof hatch. Capacity, about 1,000 bushels of new corn per side. Unless roof pitch is very steep, a crib 36 feet long should have two roof hatches.

Figure 6.—Double crib with vertical stationary elevator and bins over driveway. Note shelling trenches.

Figure 7.—Temporary cribs of welded steel mesh. Snow fencing is used in the same way.

Figure 8.—Welded-mesh round cribs protected by a roof. Each crib is 13 feet in diameter and 12 feet high. Total capacity, about 5,500 bushels; cost, 40 to 50 cents a bushel in 1948.

Figure 9.—Portable steel self-feeder for hogs; capacity, 475 bushels of ear corn.

A good many oval-shape cribs (fig. 10) are in use on Corn Belt farms. These buildings are made of ventilated building tile or concrete staves. A semicircular crib is located on each side of a central driveway. These buildings have advantages in fire resistance, rat resistance, and permanence; but many of them have provided inadequate ventilation for the corn. This defect can be overcome by using properly designed interior ventilators and by care in filling to prevent accumulations of shelled corn and foreign material. An effective

Figure 10.—Curved-wall concrete-block crib with overhead storage. Cribs have a radius of 14½ feet and walls 20 feet high. Interior ventilators are needed with moist corn.

means of improving storage results in this type of crib is the dropping of corn from the elevator onto a deflector that spreads the shelled corn out near the walls.

BUILDINGS FOR FORCED VENTILATION

Forced ventilation, with or without added heat (see p. 20), makes it possible to store ear corn in buildings that would not otherwise be

suitable. The cost of equipment for forced ventilation is largely offset by more economical construction due to the greater width of building. An arched-roofed general-purpose building arranged for storing ear corn is shown in figure 11. Satisfactory drying is accomplished by forcing air into the central duct. Plans 5722 and 5723, for wood-frame construction, have similar arrangements for drying the corn. A type of perforated floor that may be used for drying corn in either round or rectangular buildings is shown on page 22. In all cases where forced-air drying is used, large openings must be provided for escape of air from the building. The large steel cribs shown in figure 12 have perforated walls and central air ducts for forced ventilation.

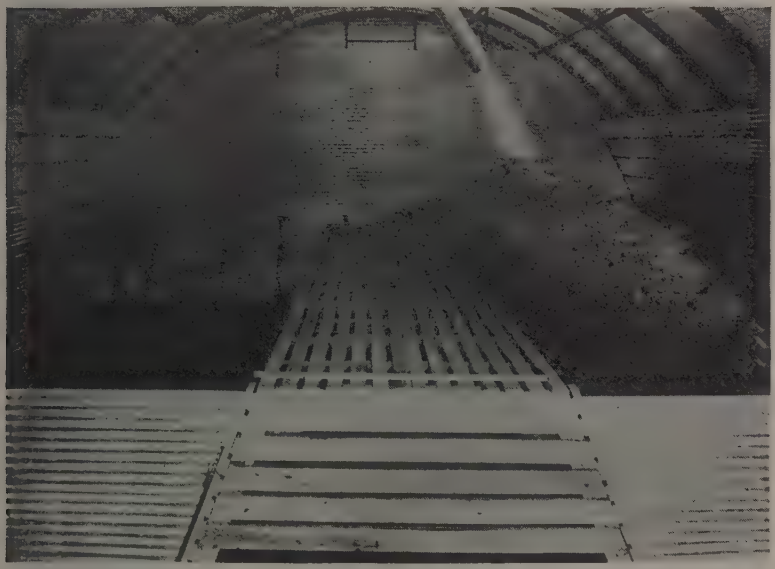


Figure 11.—A 32- by 36-foot general-purpose building arranged for storage of ear corn; capacity, 5,000 bushels. Air duct and wall braces are removable.

CONVENIENCES FOR HANDLING CORN

When corn was husked by hand, a large part of it was scooped into the crib by hand. Much labor was involved in hand scooping but there was one important advantage: shelled corn and foreign material were rather uniformly distributed throughout the mass of ear corn. When an elevator is used, the corn is dropped in one place by the elevator spout. Unless the corn is spread by dropping it onto a deflector, there will be an accumulation of shelled corn and foreign material under the spout that will cut off air movement and cause spoilage. An elevator should be equipped with a screen to take out as much shelled corn and

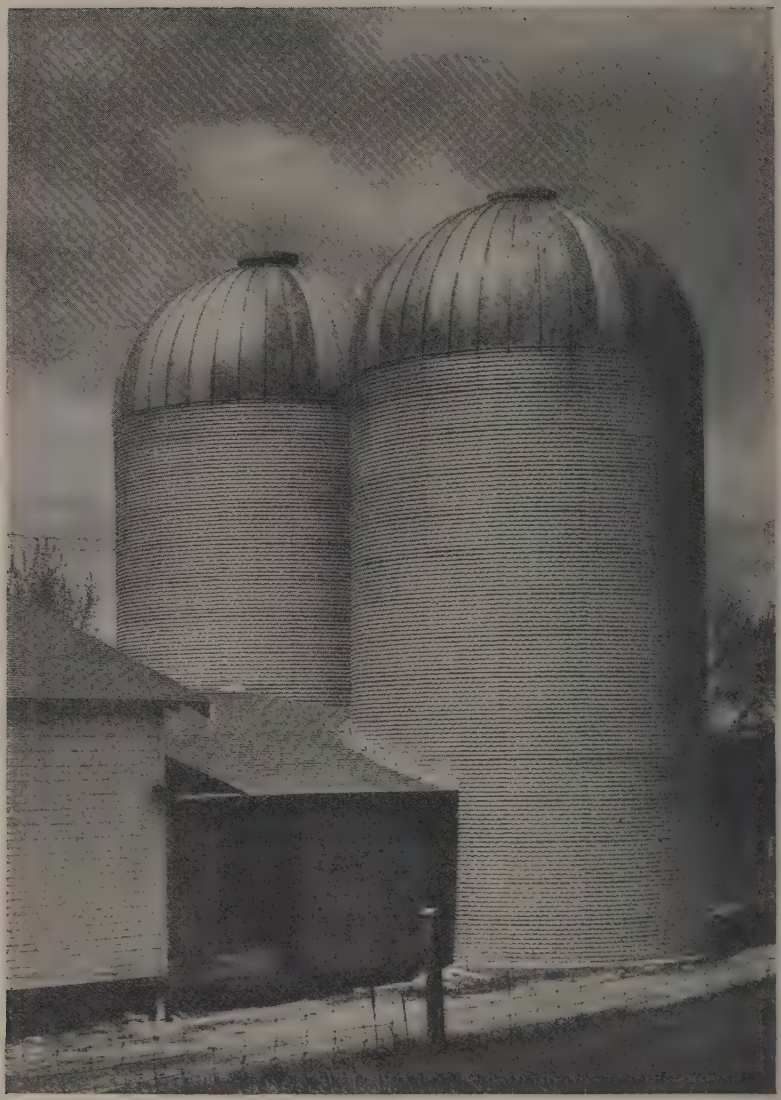


Figure 12.—Large round cribs with perforated walls and central air ducts for forced ventilation.

trash as possible; then care should be used to spread the remaining shelled corn and foreign material as uniformly as possible. Use a suitable spreading device *or move the elevator spout frequently.*

Two types of elevators are in general use in the Corn Belt. The first, a vertical stationary elevator, is used in many double-crib buildings (figs. 6 and 10). Such an elevator is practical only in this type of building and when there is a cupola large enough to house the elevator head, but it has the advantage of being able to reach to any ordinary height. The second, a portable flight-type elevator, is the one most commonly used in the Corn Belt. It can be used to fill a double crib up to 25 or 30 feet in height (fig. 5), single or temporary cribs (figs. 3, 4, and 7), or grain bins. Both types of elevators will handle ear corn or shelled or threshed grain.

For convenience in emptying, a crib should be provided with either a shelling trench (see fig. 6) or a shelling door just above the floor along one side of the crib. With either of these arrangements, a large part of the corn in the crib will roll by gravity into a sheller conveyor, or "drag," placed in the shelling trench or along the side of the crib.

CRIB CONSTRUCTION

FOUNDATIONS

The crib foundation should have footings large enough to prevent damage to the building by uneven settling. On most soils, shallow footings should have a bearing of 1 square foot on the ground for each 40 bushels of ear corn or each 50 bushels of shelled corn or wheat.

For a masonry building, the foundation walls should go down below the depth to which the ground freezes, to prevent the cracking of walls caused by the heaving action of frost. Heaving by frost action is not a serious hazard with wood-frame or steel cribs; these structures are flexible enough to stand any ordinary amount of distortion caused by such heaving. For permanent frame cribs, the foundation should go down at least 18 inches below ground surface. This minimum should be used only where no soil will wash away from the foundation.

Foundations should extend above ground far enough to protect wood from moisture and to prevent rats from working under the floor. If a wood floor is used, the lower edge of the joists should be at least 12 inches above the ground; 15 to 18 inches is better. Permanent foundations should be built of masonry, preferably concrete. In a continuous foundation wall, two $\frac{3}{8}$-inch or $\frac{1}{2}$-inch reinforcing bars, one near the bottom and one near the top, add considerably to the strength and aid in preventing cracking of the concrete.

Semipermanent or temporary foundations of concrete blocks or other materials of equal strength and permanence have been used for small and medium-size cribs. If the blocks are of good enough quality to

withstand dampness and frost action and if enough of them are used to give adequate bearing surface on the soil, these foundations will give good service. Nine 8- by 16-inch blocks laid with cores horizontal give 8 square feet of bearing surface.

ANCHORING

Empty wood or steel cribs are not heavy enough to withstand windstorms unless they are firmly anchored to the ground. If the crib is supported on a concrete foundation, bolts should be cast in the concrete in order that sills can be bolted to the foundation. If a semipermanent or temporary block foundation is used, the crib should be anchored to "dead-men" in the ground or by posts set at the wall.

FLOORS

Wood and concrete floors are the two kinds commonly used. Wood floors may be made of plain boards or of tongue-and-groove flooring. The cracks between plain boards serve to drain any water that enters through crib walls, but they are a disadvantage in mechanical drying because they allow leakage of air. Floors made of tongue-and-groove boards should be sloped to provide drainage. The floor must be supported well above the ground to permit air circulation underneath, and to be safe from damage by rats.

Concrete floors, if properly drained, have proved satisfactory for corncribs. The floor surface should be at least 8 inches above the ground on a well-drained site. The floor should slope toward the outside wall, and drainage should be provided under the sill (fig. 13). This construction is necessary for disposal of water that may enter through the crib wall during a storm. If a crib floor is supported at least 8 inches above the ground on all sides by concrete foundation and is properly drained as just specified, a gravel fill or a moisture barrier under the floor is not essential, although one of these features is desirable.

A floor made with a shelling trench of ordinary design should be 2 feet above ground level. A shelling trench provides some ventilation at the center line of the floor and saves some labor in shelling. With an 8-foot crib, the labor saving is not great, considering the work of cleaning out the trench at the end of the shelling operation. The shelling trench adds considerably to the cost of the foundation and floor.

WALL FRAMING AND BRACING

Crib walls are subjected to heavy pressures, both lateral and vertical. The vertical loads are caused by friction of corn on the walls and by the weight carried on cross braces as the corn dries and settles. Breakage of cross ties and braces has been the most common failure in

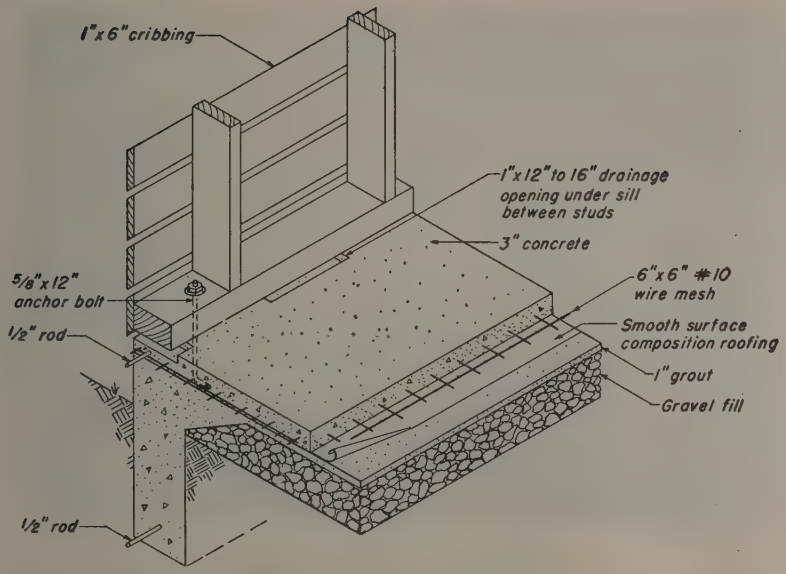


Figure 13.—Concrete floor and sill. Note anchor bolts and the drainage openings under the sill between each pair of studs. In well-drained locations, if gravel fill is used as shown, composition roofing may be omitted; if fill is earth instead of gravel, composition roofing should be used as shown.

corncribs. A cross brace made of three 1- by 12-inch boards as shown in figure 14 is superior to a brace made of the same amount of 2-inch lumber. A 1- by 12-inch board will carry more vertical load than a 2- by 6-inch plank, and because it is wider and thinner, can be more securely nailed to the studs. This type of cross brace strengthens the building so that it will resist windstorms when empty and the pressure of the corn when filled.

Elimination of cross bracing is desirable, particularly if the crib is to be used for forced ventilation. Details of constructon showing the means by which a building can be made strong without cross bracing are given in crib plans Nos. 5717 to 5720.

ROOF

A good roof is essential for storing corn safely. Roofs made of boards with battened joints have been used in some cases for temporary cribs. In a comparatively dry climate, slight leakage through such a roof may cause little if any damage, but this type of construction is not recommended. Wood shingles make a satisfactory roof and have been used more than any other material. Galvanized steel and aluminum roofing both make good roofs if securely nailed.

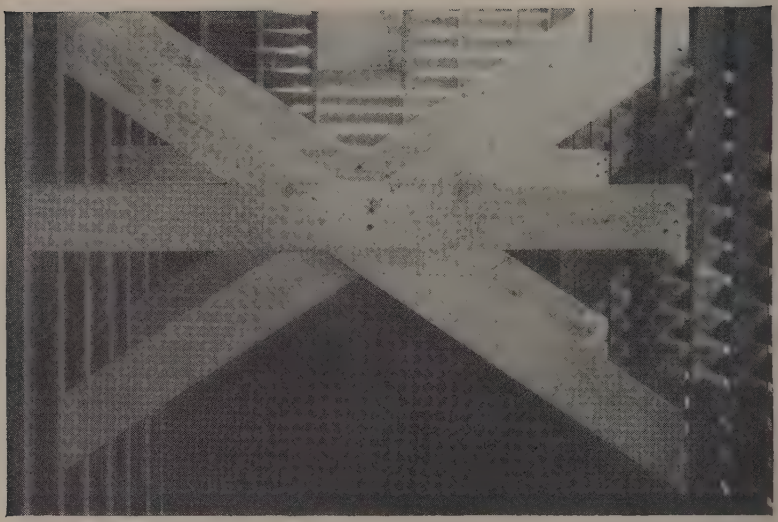


Figure 14.—A good type of cross brace. Nail each joint with 15 eightpenny nails.

Roll roofing, as usually applied, is not satisfactory, because of the wind hazard. Asphalt shingles also are subject to wind damage, but a heavy grade laid on solid sheathing and well nailed will give good service. For increased wind resistance, reduce exposure of shingles to 4 inches, or put a 1-inch dab of plastic cement under each shingle tab.

CRIB VENTILATORS

If corn has more than the safe limit of moisture or if the crib is wider than the limit recommended in figure 2, some type of interior ventilator should be used. Three types of ventilators that have proven effective are shown in figure 15. Types A and B should be installed on the center line from end to end of the crib. They practically divide the crib into two narrow cribs. If desired, type C also may be installed on the longitudinal center line instead of crosswise as shown. These ventilators are effective only up to a little above their height. Types A and C can be built in sections small enough for easy removal as the crib is emptied. Sections of type C can be placed one above another to any height desired.

Observations on corn storage have shown that vertical flue-type ventilators are not effective in cornerib. It is wind pressure that forces air movement through a crib. The air path through the ventilator should be horizontal and the ends of the ventilator should be exposed to outside air.

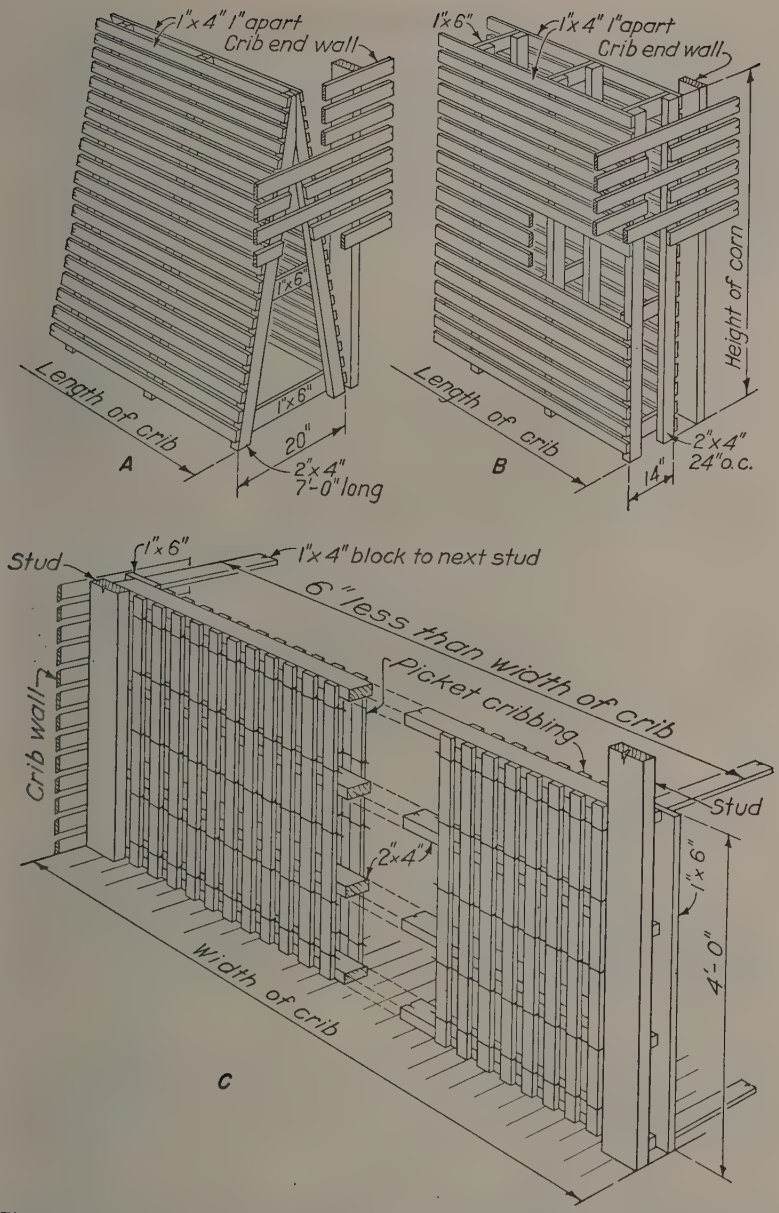


Figure 15.—Types of corncrib ventilators: *A*, A-frame, lengthwise; *B*, vertical sides, lengthwise; *C*, double vertical slats, crosswise.

By mechanically forced ventilation with either heated or unheated air, ear corn too moist for safe storage in an ordinary crib can be brought to a safe condition.

One method of mechanical drying is used as a supplement to crib storage, and in this, mechanical drying is carried only far enough to get the corn dry enough for crib storage (see pp. 22 and 24). A fan or drier may be attached as shown in figures 16 and 17, using a large canvas to form an air duct.

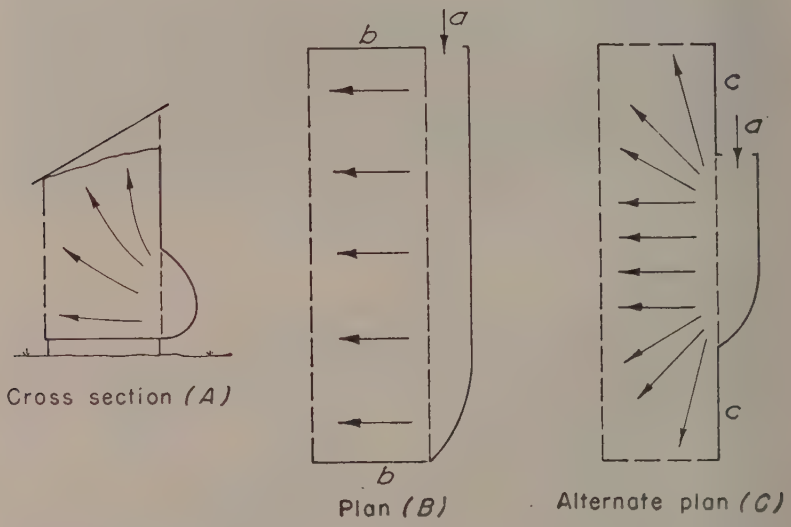


Figure 16.—Preparation of a frame single crib for ventilation, showing cross section *A* with floor plan *B* and alternate floor plan *C*. Cover end walls of crib as shown at (*b*) or side walls as shown at (*c*). Airblown in at (*a*) will then escape through the crib as indicated by arrows. Floor plan *B* is recommended over alternate plan *C*. This arrangement can be used in a double crib when it is desired to dry only one crib at a time.

Another method (with heated air) is to dry the corn to 13-percent moisture content, then shell it and store it in a weathertight bin. For this method, drying can be done somewhat more economically in a drying bin, such as that shown in figure 18 or in plan No. 5724, than in a crib. Combination drying and storage structures depending entirely on mechanical drying to cure corn are shown in plans Nos. 5722 to 5726. A perforated floor and duct arrangement that can be used for drying corn in either a steel or wood building is shown in figure 19.

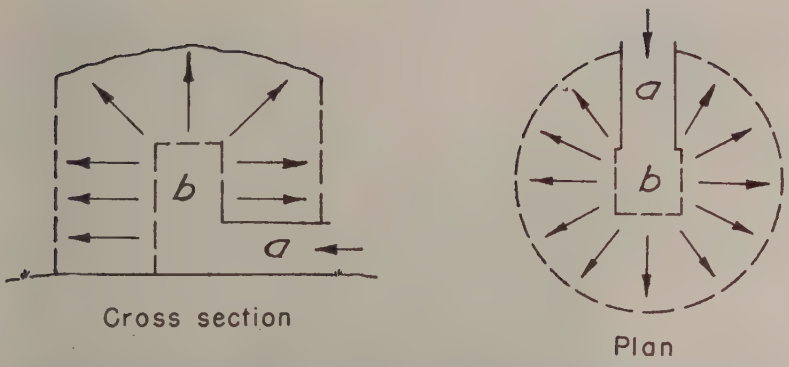


Figure 17.—Cross section and plan of a round snow-fence crib showing preparation for forced ventilation. Intake duct (*a*) should be airtight; air blown into ventilator (*b*) escapes through corn as shown.

DRYING WITH UNHEATED AIR

With unheated air the rate at which ear corn dries depends upon weather conditions. At air temperatures below 50° F., drying will be so slow that operation of the fan usually will not be profitable. Intermittent operation of the fan in cool weather will keep the corn cool, however, and thus retard or prevent mold growth. The usual procedure is to begin ventilation as soon as the crib or bin is filled. Oper-

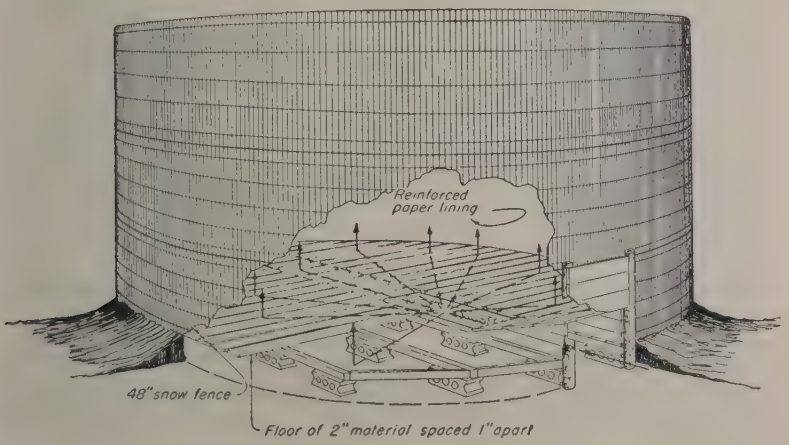


Figure 18.—A temporary drying bin with paper-lined snow-fence walls and spaced plank floor. Air passes upward through the corn. Arrows indicate direction of air flow.

ate on days when the air is relatively dry and at a temperature above 50°, preferably above 60°. On clear days in fall, the air will usually be dry enough.

When the fan is started on a warm day and the mass of corn is cold, there may be some condensation of moisture on the corn for the first hour or so of operation. This will disappear and the corn will begin to dry as it warms up. Drying will be relatively fast when the corn is warmer than the air. Operating the fan for a short time on a warm day may be detrimental rather than beneficial. If the fan is started

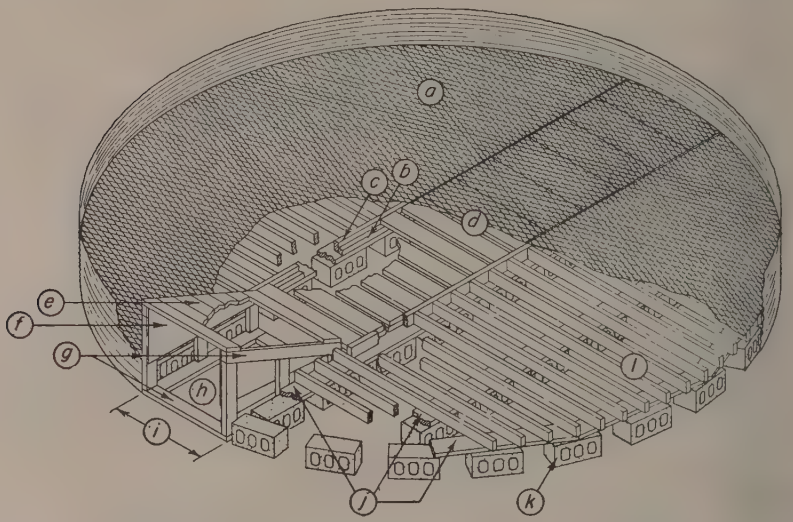


Figure 19.—Perforated floor for drying ear or shelled corn; *a*, perforated metal or ¼-inch expanded metal rolled flat, or hardware cloth; *b* and *c*, 2- by 2-inch and 2- by 4-inch stock, respectively; *d*, 2- by 8-inch planks spaced 1 inch for ear corn, 3 inches for shelled corn, with removable perforated metal sheets, 18 by 42 inches for shelled corn; *e*, 2- by 8-inch planks; *f*, ¼-inch plywood extending below floor; *g*, frame of duct of 2- by 4-inch stock; *h*, air duct, 32 inches high at door; *i*, width of door; *j*, 2-by 8-inch wood sills; *k*, 8- by 8- by 16-inch concrete blocks, 8 inches apart; *l*, 2- by 4-inch joists, 8 inches on centers.

in the warm part of the day, it should be kept running until the air and corn have cooled in the evening. If the corn is very wet, say 28 percent moisture, it may be best to operate the fan continuously day and night for the first week, except in rainy or foggy weather.

Under good conditions, the corn can be dried to 18 percent moisture in late fall and early winter. After that, if the corn is stored in a crib, natural ventilation will be sufficient. If the corn is not dried sufficiently in fall or if it is in a tight bin, additional operation of the fan will be needed as the weather warms up in spring.

The crib and duct arrangement shown in figure 20 can be used for drying with unheated air, but because of the need for intermittent operation over a long period of time, a permanent structure is more convenient. The arrangements illustrated in plan No. 5724 are suitable.

AMOUNT OF AIR NEEDED

Air flow of from 5 to 10 c. f. m. (cubic feet per minute) per bushel of corn is recommended. For a crib of 1,000 bushels capacity, a fan with a capacity of 5,000 to 10,000 c. f. m. against ½-inch resistance pressure will be needed. Both capacity and pressure are important. A fan of this capacity will require a 2- or 3-horsepower motor. Usually, it will be best to install the fan and motor permanently in the crib or bin building so that the fan can be started conveniently whenever needed.

LIMIT OF MOISTURE

Drying with unheated air depends upon weather conditions after the crib is filled, and therefore no definite limit can be set on how wet

Figure 20. Temporary set-up with a 48-inch fan and a 5-horsepower electric motor to force unheated air through one-half of a double crib. Duct is of canvas. Reinforced paper is used to prevent short-circuiting of air. (See fig. 16.)

the corn may be when cribbed. In a humid climate, the maximum permissible moisture is lower than in a dry climate. Corn with as high as 35 to 40 percent moisture has been dried by this method. However, there is risk of some spoilage of corn if the initial moisture content is 30 percent or more and if harvest is followed by a long period of humid weather.

DRYING WITH HEATED AIR [4]

When corn is to be dried by heated air in farm cribs, it can be done most economically by means of portable equipment consisting of a

Figure 21.--Forced-air drying with heated air. One side of a double crib with a 4-foot alleyway has been filled and is being dried while the other side is being filled. Air is forced into the alleyway. The side and top of the alleyway next to the empty crib are lined with paper. Ends of crib being dried are also papered.

power-driven fan and an oil burner or other means of heating the air. This equipment can be assembled into a unit mounted on a rubber-tired trailer for convenient transportation from crib to crib and from farm to farm. It may be attached to blow air into a crib as shown in figures 21 and 22. One drier can be used to dry several cribs of corn, and the equipment cost per bushel will be correspondingly lower than when a stationary drier is installed at a crib.

[4] For further information see U. S. Department of Agriculture, Bureau of Plant Industry, Soils, and Agricultural Engineering, Information Series, Mechanical Drying of Corn on the Farm.

Figure 22.—Tight-walled building used as a batch-drier for ear corn. Heated air forced into the center duct passes sideward and upward through the corn. Wire mesh on the inner face of the side-wall studs (not the end-wall studs) allows air to escape. Note drier at left and portable elevator for filling. Corn is removed through a shelling trench.

Drying can be done more economically in mild fall weather than in cold winter weather, but when necessary, the drier can be operated throughout the winter and early spring months.

There is considerable variation in rates of air flow and amount of heat that may be applied. Under ordinary conditions, air flow anywhere from 5 to 15 c. f. m. (cubic feet per minute) per bushel of corn will give economical results. For drying in late fall or winter weather, the heater should have capacity to heat the drying air to about 70° F. above atmospheric temperature, but in warm weather it may be desirable to heat the air only 20° to 30° above atmosphere. Drying will be faster (but not necessarily more economical) at high temperature and high rates of air flow. Temperatures above 130° are not recommended in farm driers.

COST OF DRYING CORN

The cost of mechanical drying will vary with the amount of moisture that must be removed from the corn and is influenced also by weather conditions when the drying is done.

Suppose the initial moisture content of the corn is 25 percent and it is dried down to an average of 18 percent to make it safe for crib storage. The cost of power for drying by forced ventilation with unheated air under favorable weather conditions will be about 2 to 3 cents per bushel. To this must be added labor and the annual cost of owning the fan and motor (interest, depreciation, and like expenses), which may bring the cost up to 5 to 7 cents per bushel or even more if conditions are not favorable.

Drying with heated air is more reliable but its cost is likely to be higher. For the amount of drying just specified, the total cost, including fuel, power, labor, insurance, and the cost of owning the equipment, is likely to be 10 to 12 cents per bushel. If the corn is contained in a steel bin and the drier is fire-safe when operating without an attendant, the labor and insurance costs will be materially reduced and the total cost may be no more than for drying with unheated air.

RAT CONTROL [5]

Rats and mice sometimes cause heavy losses of cribbed corn, especially when corn is held in the crib for a year or longer. No ordinary construction will completely exclude rats and mice, but their activities will be greatly reduced by the use of concrete floors or by wood floors supported well above the ground as shown in plans Nos. 5717 to 5720.

CORN STORAGE PLANS

The following plans for storage buildings have been prepared by the United States Department of Agriculture in cooperation with State agricultural experiment stations of the North Central States:

U. S. P. A. Plan No.	Midwest Plan No.	Description
		Storage Buildings
5717	73272	Single wood crib.
5718	73282	Double wood crib with driveway.
5719	73281	Double wood crib with 4-foot alleyway.
5720	73283	Double wood crib with driveway and overhead bins.
5721	73271	Pole crib, semipermanent.

[5] SILVER, J., CROUCH, W. E., and BETTS, M. C. RAT-PROOFING BUILDINGS AND PREMISES. U. S. Dept. Int. Conservation Bulletin 19, Fish and Wildlife Service, 26 pp. illus. 1942.

5722	74133	Round-roof building (convertible to hay or machinery storage).
5723	75513	Gable-roof building (convertible to hay or machinery storage).
5724	75503	Steel bin with perforated floor.
5725	77615	Movable drying, storage, and self-feeder for hogs.
5726	77416	Movable drying, storage, and self-feeder for cattle.

An illustrated catalog issued by the Midwest Plan Service sponsored by the State agricultural colleges of the North Central States and the United States Department of Agriculture may be consulted at many county agricultural agents' and material dealers' offices. Detailed working plans may be obtained for a small charge through the State extension agricultural engineer. In some States these drawings may be obtained only through county agents. Do not order from the United States Department of Agriculture.

U. S. GOVERNMENT PRINTING OFFICE: 1949

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 10 cents